DEPARTMENT OF AGRICULTURE,

JAMAICA.

Entomological Circular, No. 3 of 1921.

—THE—

CITRUS BLACK FLY,

(Aleurocanthus woglumi, Ashby)

—BY—

C. C. GOWDEY, B.Sc., F.E.S., F.Z.S.,

Government Entomologist, Jamaica.

JAMAICA
GOVERNMENT PRINTING OFFICE, KINGSTON.
1921.

—THE—

CITRUS BLACK FLY,

(Aleurocanthus woglumi, Ashby)

——BY——

C. C. GOWDEY, B.Sc., F.E.S., F.Z.S.,

Government Entomologist, Jamaica.

PLATE I.—LEAVES OF LIME COATED WITH "SOOTY FUNGUS."

(U. S. Dept. Agric.)

CIRCULAR No. 3.

THE CITRUS BLACK FLY

(*Aleurocanthus woglumi*, ASHBY)

By

C. C. GOWDEY, B.Sc., F.E.S., F.Z.S.

Government Entomologist, Jamaica,

With Notes on Control by Fungi,

By

S. F. ASHBY, B.Sc., Microbiologist.

INTRODUCTION

Aleurocanthus woglumi belongs to a family of bugs known as *Aleurodidae*, or White Flies. They are closely related to the scale insects, *Coccidae*, which they resemble in their immature stages, but from which in the adult stage they are separated by the fact that they possess two pairs of wings. The adults are minute moth-like insects with floury wings.

The popular name for the family—White-Flies—is not applicable to this insect, as in all of its stages it is of a black or dusky hue. It goes by the common name of the Black Fly or the Citrus Black Fly in Jamaica and Florida and in Central America and Cuba by *mosca prieta*. It is sometimes referred to as the Spiny Citrus White Fly to distinguish it from the Citrus White Fly of Florida.

DISTRIBUTION

The Black Fly was first recorded from the East, in India and Ceylon in 1910, whence it has been introduced into the tropics of the New World and is now recorded from Costa Rica, Cuba, Jamaica, Panama and Providence, Bahamas. Ashby (1) considers that this pest "was probably brought here on mango cuttings from India within the last 20 years," though other investigators consider it to be a more recent importation.

DESCRIPTION

This insect has a complete metamorphosis, that is, it passes through series of changes during growth from the egg through the larval

and pupal stages to the adult. The larvæ molt three times, the third bringing the insect to the pupal stage. The interval between each molt is known as an *instar* and are referred to herein as the first, second and third instars, respectively; the first instar being the interval between the emergence of the young from the egg and the first molt.

In the earlier stages—larva and pupal—the insect is scale-like and quiescent, being fixed to the under surface of the leaves.

Egg—Colour, creamy-white, changing to brown; surface reticulated; form, canoe or sausage-shaped with rounded ends, attached to a stalk, or pedicel at posterior end.

Larva—As stated above, there are three larval stages, or instars, during which there are certain changes in appearance.

First Instar—Colour, white, becoming black soon after its emergence from the egg; eye-spots, reddish; shape, elongate, but soon becomes oval and flattened.

Second Instar—Colour, soon after molting, whitish, but soon becomes black with a dull green spot on the dorsum; shape, more oval and more convex than in the preceeding instar; margin whitish, bearing fairly numerous spines, to which the molted skin remains attached.

Third Instar—Colour, black with a green spot extending over the greater part of the thorax and part of the abdomen; shape, oval convex; spines numerous and, as in the preceeding instar, the molted skin is attached to them. In this instar the males are distinguishable from the females by their smaller size.

Pupa—Colour, at first creamy, changing to shiny black later; shape, at first oval, flat, but later becoming convex; spines, long, stout. The males in this stage can be distinguished, apart from their smaller size, by the fact that they secrete more wax on the margins of their bodies than do the females.

Adult—Colour, when first emerged from the pupa, brick-red, with the exceptions of the antennæ and legs, which are whitish and of the front of the head, which is yellowish; later, usually by the end of 12 hours, colour changes to dusky brown, with the following exceptions—sutures on the thorax and the whole abdomen brick-red, antennæ pale yellowish, eyes reddish-brown, lower lip and legs yellowish, still later, usually by the end of 24 hours, the insect is slaty blue in appearance, due to its becoming covered with a powder, with the exception on the wings of certain spots which have the appearance of a band when the insect is at rest. The males differ from the females in being smaller and having their abdomen more slender. Size of female 1.15 mm.; of male 0.8 mm.

Life History and Habits

The eggs are laid in the form of a spiral, more or less irregular, and less apparently so when a large number of eggs is crowded on the leaf. The female starts laying the first egg in the centre of the spiral and swings outwards. The eggs are deposited on the underside of the leaves. The average number of eggs in a spiral is about 35. Egg-layiing begins

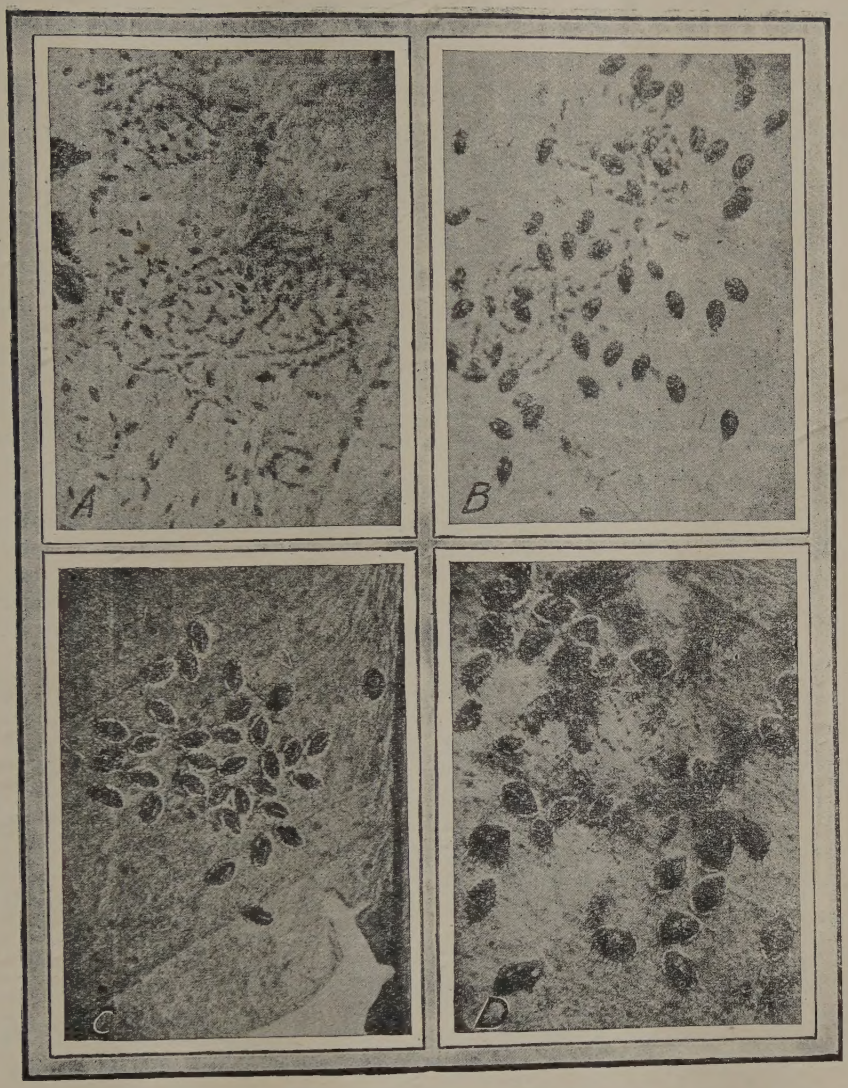

PLATE II.—A. EGGS AND FIRST INSTAR LARVAE; B. EGGS AND THIRD INSTAR LARVAE; C. MALE PUPAE; D. FEMALE PUPAE.

(U. S. Dept. Agric.)

at any time between one and four days, usually sooner than the maximum, after the female has emerged from the pupal case and takes place during the earlier part of the morning or on a cloudy afternoon. The incubation period takes from 7 to 10 days.

The larva emerges from the egg-shell through a slit on the dorsum. On emerging it crawls around within a short distance of the egg spiral and shortly settles down near it. Honey dew is secreted during this stage. The duration of the three larval instars is as follows—First Instar, 7 to 14 days; Second Instar, 8 to 12 days; Third Instar, 8 to 14 days. Thus making the duration of the larval stage of from 23 to 40 days.

During the pupal stage honey dew is also secreted. The duration of this stage is from 16 to 48 days, the maximum being unusual.

The adult emerges from the pupal case through a T-shaped slit. Emergence usually takes place during the earlier part of the morning or on a cloudy afternoon. On emergence the adult remains near its pupal case until its body hardens. The number of females usually exceeds that of the males. especially in the case of light infestations. Both sexes seem to gather on the young foliage at the tips of branches. Copulation takes places soon after the hardening of the body and usually in the late afternoon.

Therefore, not including the length of life as an adult, the life-cycle of the insect requires from 46 to 98 days for completion.

Parthenogenesis

Parthenogenesis is the reproduction by direct growth of germs from egg-cells without fertilization by the male. As in other members of this family, this phenomenon occurs in the case of the Black Fly and more frequently during drought and also the adults so reproduced are males. That parthenogenesis occurs more often during drought and that the adults are males is explained by Dietz by saying that as the mortality amongst the insects during a drought is so great that there are few males to fertilize the females.

Number of Generations

Calculating on the number of days needed for the completion of the life-cycle of the Black Fly there would be sufficeint time in a year for the development of three to six generations. The number of generations, though, is influenced by the wet and dry seasons, both of which are factors influencing the development of the insect.

The generations are not clear-cut, that is, the insects of one generation do not reach the adult stage before the eggs, and even the later stages, of the following generation are met with; but the generations over-lap and the insect may be found in all stages of development on the same tree.

Food Plants

The Black Fly has been recorded as occurring on seventy-five food plants. One authority (2) divides the food plants into three classes—"(1) The favourite or preferred food plants i. e., those that become

heavily infested with the insect and on which complete development from egg to adult takes place; (2) The occasional food plants, i.e., those on which complete development of the insect can and does take place, but which apparently do not become heavily infested with it; (3) Supplemental food plants, or those which the adults may visit and from which they may obtain food, but on which either they do not lay eggs or, if they do, complete development does not take place."

Classifying the Jamaican food plants of this pest according to the above divisions, they are arranged as follows:—

1 Favourite Food Plants.	11 Occasional Food Plants.	111 Supplemental Food Plants.
Citrus—Orange, grape fruit, limes, tangerines.	Sour Sop	Banana (?)
Coffee	Guava	Yam.
Mango	Sweet Sop	
	Avocado	
	Breadfruit	
	Star apple	
	Grape	
	Jessamine, night-blooming	
	Lignum-vitae	
	Mahiva (*Bassia latifolia*)	
	Wampie (*Clausenia wampi*)	

The writer has never observed any stages of the Black Fly on bananas in the field and under laboratory conditions has failed to rear the insect beyond the first instar. Dietz (2) regards bananas as a supplemental food plant, having seen but three cases of this insect occurring on bananas which were growing in the vicinity of a heavily infested mango tree, but also having failed to rear the insect through to the adult stage on this fruit as food.

Injury

The larvæ suck the sap from the leaves and cause them to drop when heavily infested. The extent of defoliation has been estimated at from 5 to 10 per cent. The falling of the leaves usually takes place in the dry season and it cannot be gainsaid that the excessive giving off of moisture by the leaf in the dry season adds its quota to and assists in the degree of defoliation. Though this partial defoliation must necessarily tend to lessen the vitality of the tree, at the same time it aids in checking the infestation, for when a leaf infested with any of the stages of

the Black Fly—eggs, larvæ, pupæ—falls and wilts those stages fail to reach maturity as under such circumstances the requisite amount of moisture for the development of the insect is not available.

The Black Fly secretes a juice ("honey dew") on which a black fungus develops. The presence of this fungus causes the foliage and fruit to be unsightly, and may, if the leaves are heavily coated, interfere with the normal functions of the leaves.

This insect has not been recorded as feeding on the fruit. Though, that it does feed on the fruit is frequently believed, the belief gaining foothold from the presence of the sooty fungus on the fruit. The presence of the sooty fungus is due to the dropping of the honey dew from the insects on the foliage above to the fruit beneath and the growth of the fungus results.

It has been stated (4) that infestations of the Black Fly quickly result in the shortening of the life of the infested tree. It seems to me to have been proved (2) that such is not the case, that well cared-for trees and trees not infested with other insects, such as the Purple Scale, Snow Scale and West Indian Red Scale do not succumb. However it stands to reason that trees heavily infested with the Black Fly must show the result of the heavy drain on its sap by these insects and the result of such a loss of sap will be evidenced in the quality, if not in the quantity of the fruit.

Dissemination of the Pest

The principal ways in which the Black Fly may be disseminated from a locality in which it is well established to a new locality are by—

(1) The natural method of migration or flight of the adults from infested trees to uninfested trees. The spread of an infestation from a less preferred food plant to a favourite food plant, for instance, the spread of the adults from a breadfruit tree to an orange tree, usually takes place in this manner.

(2) Winds assisting the flight or migration of the adults. This manner of dissemination can to a large extent, in the case of large groves, be controlled by the use of wind-breaks.

(3) The carrying of infested plants to clean localities. This method of dissemination can easily be avoided and guarded against.

(4) The carrying of adults on travellers and vehicles to clean localities.

Natural Checks

Climatic Factors—Both heavy rains and prolonged drought assist in checking the development of the Black Fly. If heavy rains occur soon after any of the three larval molts or soon after the emergence of the adults from the pupal cases, large numbers of the insect at these stages of development perish, as it is at these points that the insect is the most delicate.

During a drought there is a high mortality amongst the young larvæ and amongst the emerging adults, for moisture is an essential factor for the successful molting of the larvæ and emergence of the adults from the pupal cases. Also, as previously stated, the greater part of the defoliation on account of infestations of this insect takes place during drought and the insects on the fallen leaves fail to reach maturity.

Natural Enemies—The larvæ of one species of lace-wing fly (*Chrysopa sp.*) and at least three species of Coccinellids, or lady-beetles, are known to prey on the larvæ and pupæ of the Black Fly. But, although

they must exercise a certain influence on the numbers of the pest, apparently they cannot be relied on to check the infestations.

Relationship of Ants to the Black Fly.—After careful observations in regard to the question as to whether or not ants play any part in the control of the Black Fly, I have arrived at the conclusion that under certain conditions the ant, *Cremastogaster brevispinosa*, Mayr., var. *minutior*, For., is beneficial in this respect. On several occasions these ants have been observed attacking the pupæ and adults of the Black Fly. Moreover, in several localities there are *Citrus* trees growing side by side, some of which are heavily infested with the Black Fly, while others with colonies of this ant are free, or practically so, from the Black Fly. To this fact of the cleanness, or relative cleanness, of such trees, there is, so far a I have been able to determine, no other attributable cause. On the other hand, there are two known instances in which this ant has absolutely failed to have any appreciable effect on infestations of the Black Fly. The only theory which the writer can advance in explanation of such failures is that there is in those instances a food supply preferred by the ant to the Black Fly, the Black Fly being a relatively recent importation.

With regard to the question as to whether this ant may safely be spread by artificial means throughout the island, my views are that though it is within the realm of probability it may adopt the habit of colonizing scale insects, but given that it aids in the control of the Black Fly it would be an easy matter to control the ant should it adopt undesirable habits, its control being a matter relatively very easy as compared with the control of the Black Fly by artificial measures. Furthermore, if artificial dissemination be not undertaken the ant would spread naturally, though it may not be able to maintain itself under all the different conditions found on the island. Therefore, in my opinion there would be no ultimate or irreparable harm in the artificial stocking of *Citrus* trees with the colonies of this ant, it being under certain conditions a natural check on the Black Fly.

"FUNGI." BY S. F. ASHBY, B.Sc., Microbiologist.

Fungi Parasitic on the Black Fly—Several species of fungi attack and kill the black fly in the three larval stages in Jamaica. Two of these species are widely distributed and often abundantly present on the larvæ. They are the "bright red fungus" (*Aschersonia aleyrodis*, Webb) and the 'dull red' or 'brown fungus' (*Aegerita Webberi*, Fawe.)

The Bright Red Fungus—After killing the larva this fungus develops round the insect as a white fringe which grows up and finally completely covers it, forming a raised, rather flattened, dense white growth or *stroma*. As this growth matures numerous pockets develop within it which open to the surface by holes or slits through which the spores ooze out. The masses of spores run together and form a bright coral-red cap which is pasty when moist but hardens as it dries. The cap consists of countless numbers of minute spindle-shaped spores, individually colourless but bright red in mass. In contact with water the spore masses break up rapidly into the individual spores. The spores are, therefore, readily spread by rain or heavy dew to lower leaves of the same tree or may be swept by breeze in rain drops to the leaves of neighbouring trees. After lying on the moist surface of a leaf for a few hours each spore gives out a fine thread which grows in length and branches. If during its growth a larva of the black fly is reached infection occurs; the fungus grows in the tissues of the insect, kills it, spreads

round it again, grows over it and develops the masses of spores. Where the colonies of larvæ are crowded it is probable that the threads of the fungus growing out from a dead insect, are able to infect those near it. While the isolated spores soon die when dry, many of them in the spore masses retain their ability to germinate for weeks or perhaps months so that dry leaves carrying spore masses can be used after a month at least for spreading the fungus by one of the methods to be described later.

It should be remembered that this fungus is white until the spores appear. It may require a week or more to reach the sporing stage after the white fringes show round the larvæ. The production of spores continues for some days. When that ceases the spore masses break up when the leaf is wetted and are washed away leaving the stroma (showing the holes or slits now very distinctly under a hand magnifier) to weather, loosen and fall or be washed off. During weathering it turns grey and often nearly black, due to attack by saprophytes, such as, *Cladosporium herbarum* or an overgrowth of sooty mould. This fungus also attacks the white flies of Citrus in Florida, where it makes rapid progress in some localities during the rainy warm summer months from May or June onwards, but is rather at a stand still during the cold drier months from November to March. As the spores require moisture lasting for some hours to germinate and infect, the fungus cannot spread appreciably during dry weather, except in favourable situations where there is a heavy night dew and early morning mist ensuring a humid period long enough for spore germination and infection. It is also probable that in dry weather the stroma is less developed and spore production is less copious.

The Dull Red or Brown Fungus.—This fungus develops a low dome-shaped, closely felted stroma completely covering the dead larvæ. The colour is variable, but is frequently a dull reddish-purple becoming later light brown and finally a darker brown. This fungus spreads widely over the under surface of the leaves as white silky threads united into a thin skin or pellicle and no doubt this power of extension results in many larvæ on a leaf becoming infected from one centre. Long threads also grow out from the dome-shaped stroma which reach the margin of the leaf and extend to the upper surface. The so-called spores are developed on these threads frequently at a considerable distance from the stroma. These reproductive bodies consist of a closely united group of irregular rounded cells like a black-berry with from three to five or more blunt spines projecting from the body. These brown bodies (large enough to be seen by a hand magnifier) can be found in groups scattered over both sides of the leaf and also frequently along the edges of the leaf. They break away easily when ripe. The usual mode of distribution is not known, but if the cells contain air it is likely that they can be carried by air currents as well as by rain-wash and rain-drip. It is also probable that the spines may cause them to be caught up on the legs of insects—especially of ants. After lying some hours in water the spines give rise to threads which may infect any larvæ reached by them. Although the number of these reproductive bodies developed is very small in comparison with the vast number of spores produced by the bright red fungus, the brown fungus is frequently as abundant on the larvæ as the former. This is doubtless due to the widely spreading habit of the mycelium of the brown fungus on the leaf and also to the greater resistance of its reproductive bodies against dessiccation. Trials have

shown that the brown fungus can also be spread artificially by spraying. It is also probable that it is less dependent on high humidity and high temperature than the bright red fungus.

The Cinnamon Fungus, (*Verticellum heterocladum*, Penz.) with a stroma of the colour indicated by the name has also been found on the Black Fly. Although spores are produced in abundance it is less frequently found than the other two fungi, and is of less importance from the stand point of Black Fly control.

Effectiveness of the Fungi—The fungi are quite dependent on humidity for development and spread, so that as a rule, it is only during and following the rainy seasons that they can work effectively. In the more humid districts with a well distributed rainfall they can keep the fly under some measure of control, but in districts with a long dry season the Black Fly goes ahead and can cause injury before the fungi can develop sufficiently to effect temporary control. In some of the wetter districts in Florida the fungi become very abundant in the late summer and fall on the white fly and the following year there is very little fly. The year after the fly increases again during the late spring and early summer to an injurious extent and is again heavily attacked by the fungi in the late summer and fall. This occurs where the fungi are allowed to develop naturally. If they are applied on leaves or by spraying in the late spring and early summer when the fly is in the larval stages, they become effective much earlier than when they are left to a appear naturally. Even in Florida where the summer is wet and warm and very favourable to fungus growth their effectiveness varies much in the same district, but it is evident that excellent results have been secured in numbers of citrus groves by spraying on the fungi two or three times in the year even when they are present naturally. It has been observed in Jamaica that when the Black Fly spreads to a new district the fungi are slow to follow. The first year the fly is unrestrained and it is only in the second year that they begin to show. Their appearance could doubtless be brought about the first year by pinning up leaves bearing their spores or by spraying on the spores, provided it was done when the fly is mostly in the larval stages and the weather favours infection and spread later on.

Application of the Fungi 1. *By Pinning on Leaves.*—A dozen leaves each bearing a dozen or more pustules of the fungi are pinned on the leaves as high up in the tree as is practicable and in such a position that rain drip will fall on a number of leaves beneath. The leaves bearing the fungi should be attached with two pins to the undersides of the leaves and a fragment of white paper pinned to the upper sides of the treated leaves, so that they can be readily seen when an inspection is made later. The infection may not start on the treated leaves but on some below them. In favourable weather the white fringe round the larvæ may show in two weeks, but it may require 4 to 6 weeks before infection shows up. In the case of the bright red fungus, leaves should be selected for pinning which show conspicuous red spore caps. Dry leaves may be used if picked not much more than a month before and kept in a dry place, but fresh leaves are to be preferred.

2. *By Spraying on Spores.*—This method is especially applicable to the bright red fungus, but it has also been successful with the brown fungus. A score of leaves each showing ten or more bright red spore masses of the red fungus should be soaked in a gallon of clean water

in a tinned or iron bucket or pan or wooden vessel for half or one hour and stirred up at intervals so as to diffuse the spores in the water. A final stirring is then given and the liquid poured through cheese cloth or a fine strainer into the spraying tank or into another vessel if a syringe is to be used*. The spray should be applied to the under sides of the leaves as a fine mist and one quart is sufficient for a medium sized tree. The spray tank should not have been used with bordeaux or burgundy mixture, but can be used after lime-sulphur wash or cattle dip if thoroughly washed out. There is greater risk of reducing the germination of the spores if the tank is of copper or brass than if of galvanised steel.* The danger is slight, however, if the water holding the spores is sprayed on within a few minutes of charging the tank. If a spray tank is not available the Abol syringe is well suited for spraying on the spores as the nozzle can be adjusted to give a mist-like spray. In the absence of both tank and syringe the spores can be applied by means of a whisk broom.

When to Apply the Fungi—The best time to apply the fungi is after the tree has flushed and the larvæ are hatching out from the eggs on the young foliage. Rainy weather will greatly increase the chances of infection. It is useless to apply the fungi to trees in old foliage as only the empty pupal cases are present.

Where the fly is establishing itself in a Citrus cultivation for the first time the fungi may require a year or more to appear and in the meantime the fly may increase greatly and cause much injury. An attempt should be made, therefore, to introduce the fungi as soon after the fly appears as possible. A group of three or four healthy trees should be selected in a part of the cultivation protected from breeze and leaves pinned on to them and spores sprayed on. If the fungi do not begin to show up after a month, the pinning up and spraying should be repeated and again after a month, if necessary. If the weather is at all favourable and the application has been made when the fly is in the larval stage success is almost certain. Dry leaves can be used for the second and third applications if fresh material is not available. Dry leaves should be preserved hung up in a bag after drying in a shady place. If such leaves are brittle they should be allowed to lie on a layer of wet sawdust or wet wadding in a closed pan for a few hours before pinning up. In this way a good infection can be established on a few trees which will supply enough leaves for spreading the fungi to the rest of the cultivation by pinning up and spraying. In cultivations where the fly has been established for some years and the fungi are present, pinning up and especially spraying may help greatly in getting the fungi active on the larvæ earlier in the season than would happen in the natural way. On such cultivation the fungi should be applied each year after the spring flush, soon after the fly begins to lay eggs on the new foliage. As fresh leaves bearing the fungi may not be available at this time, well infected leaves showing numbers of the red spore caps of the *aschersonia*, or pustules, of the brown fungus should be picked late in the preceding year and preserved dry for this spring application. Two or

---

*Note**—The Lowell compressed air sprayer of galvanised steel and of three gallons capacity has been found very suitable in Florida. It is carried in one hand with a strap over one shoulder. The agent in Florida is the E. O. Painter Co., Jacksonville. It was selling in 1916 for 5½ dollars—extension rods extra.

three applications at intervals of a month have been found to give substantially better results than one spraying.

The following eight points have been put forward in Florida for establishing the fungi on the white flies there. (E. W. Berger in Bull. 88, Florida Agr. Expt. Sta.).

1. Get them into your infested trees at almost any price.
2. By spraying on the spores.
3. By pinning up leaves.
4. Mulch the trees and where convenient keep the mulch damp by an occasional wetting.
5. Spray the trees often with water in dry weather.
6. Permit the cover crop to grow tall in the grove and let it remain there as long as possible.
7. Plant wind breaks.
8. Spray again with fungus spores and oftener, if necessary, in order to get a good start of fungus.

The Sooty Mould

This black fungus (*Meliola* sp.) usually spreads over the upper sides of the leaves and on the stem end of the fruit where there is infestation of Black Fly, but it may also occur where there is no Black Fly but where some kinds of scale insects are present. The Black Fly and these scales secrete a sugary fluid (honeydew), which drips on to the leaves below and is spread over their upper surface by rain. The sooty mould grows on the honey dew without attacking the leaves. It can be peeled off, leaving the leaf surface fresh and green. It screens the leaves from the sun and if abundant may, for that reason, reduce their power of forming the organic food required for growth and fruit production. It is mainly objectionable as it renders the fruit unsightly and necessitates washing—an additional expense at the packing house. It is evident that where it is due to the Black Fy the control of that insect will cause lessenning or disappearance of the sooty mould. It does not begin to appear until the trees have been infested by the Black Fly for some months so that early introduction of the red and brown fungi by pinning up leaves or by spraying on spores may indirectly control it also.

Artificial Control

The Black Fly can be controlled by spraying with contact insecticides. But the situation in Jamaica is complicated and made so much more difficult on account of, in most cases, the neglected state in which the host plants of this insect are allowed to grow. Also, in order that the clean condition of a tree as a result of spraying to be less transient spraying operations should not be confined to a few growers in a locality; but the campaign must be carried out by all the growers of the food plants of the Black Fly in that locality, for, as it has already been pointed out, the adults fly or migrate from one food plant to another and particularly from a less preferred food plant to a favourite food plant. Therefore, unless there is co-operation in a given locality this method of control is doomed to failure.

The contact insecticides which have given the best results are whale oil soap, kerosene emulsion, "Black Leaf 40."

Whale oil Soap

Formula—Whale Oil Soap....1lb.,
Water.....2 to 4 gals.

To be repeated after an interval of one week, if necessary.

Kerosene Emulsion

Formula—For preparing the stock solution:—

Kerosene.....1 gal.,
Soap, Hard.....10 ozs.,
Water..... 1 gal.

To form the emulsion dissolve the soap, shaved finely, in hot water and then add the kerosene. Agitate the solution until a white creamy mixture is formed. One of the best means of doing this is to run the solution through a spray pump, driving it back into the vessel from which the solution is drawn and after about five to ten minutes of this mixing a perfect emulsion will result. It is important that a perfect emulsion be obtained, as otherwise the oil will separate from the water with the result that the foliage will be damaged.

The stock solution must be diluted with 18 parts of water before application.

"Black Leaf 40"

This is a solution of nicotene sulphate, containing 40% active nicotene. The ordinary dilution of this insecticide is one part to 800 parts of water with the addition of 2 lbs. of ordinary soap dissolved in boiling water to every 50 gallons of diluted "Black Leaf 40." In a small amount the formula would be as follows :

"Black Leaf 40".....1¼ teaspoonfuls,
Soap, ordinary.....2-3 oz.,
Water.....1 gal.

To be repeated after an interval of a week, if necessary.

With regard to spraying operations against the Black Fly the following points should be borne in mind:—

(1) That the best time to spray is during the dry season.
(2) That for a contact insecticide to be successful the spray must come into actual contact with the insects.
(3) That better results will be obtained by applying a fine spray and, moreover, that it is cheaper.
(4) That, as the adults fly or migrate from foodplant to food plant and invariably from a less preferred food plant to a favourite food plant, attention should be given to food plants in out-of-the-way places if one desires to reap permanent benefit from one's spraying operations; otherwise, the sprayed trees will soon become re-infested from the neglected food plants growing in the vicinity of the former.
(5) That the operation of spraying will be made easier and cheaper by previously pruning, if needed, the trees to be sprayed.

References to Literature Consulted

(1) Ashby, S. F.—Annual Report Department of Agriculture, Jamaica, for year ending March, 31st 1915.
(2) Dietz, H. F. and Zetek, J.—U. S. Department Agricultural, Bul. 885 (1920.)
(3) Hutson, J. C.—Comision de Sanidad Vegetal, Bul. 1 (1917.)
(4) Newell, W.—A New Menace, The Black Fly. In Fla. Grower, V., 17, No. 21, May 25th, 1918.